REMARKS

When last examined, the above-identified patent application included Claims 1-18. Claims 2 and 12 have been canceled, and Claims 1, 4, 6, 7, 9, 11, and 14-18 have been amended.

In the clean version of the entire set of pending claims presented in Applicants' response to the previous Office Action, the word "wherein" was inadvertently inserted into Claims 15 and 16. The present submission corrects this error by deleting "wherein" from Claims 15 and 16.

The Examiner objected to the drawings as failing to comply with 37 CFR §1.84(p)(5) because they include reference character "hν" and reference character "21" not described in the specification. On page 3 of Applicants' response to the previous Office Action, Applicants amended the paragraph of the specification beginning at page 8, line 23 to include a reference to "semiconductor 21." As explained on page 8 of the same response, this addition is clearly supported in the specification, claims, and figures as filed. In the present submission, the paragraph of the specification beginning at page 6, line 1 has been amended to include the statement "[s]ymbol hν in Figure 1 designates the path of a photon reflected by multi-layer contact 12." Since the symbol hν is well known to designate a photon of light by referring to its energy (Planck's constant h multiplied by the frequency of the light ν), this addition to the specification is also clearly supported by the figures. Hence, as amended the specification discloses the reference characters "hν" and "21" and the drawings thus satisfy the requirements of 37 CFR §1.84(p)(5).

The Examiner objected to the specification as missing some simple description about I and V as used in "(linear I-V)" at page 6, line 11. The specification has been amended at page 6 lines 11-12 to read "(linear I-V, where 'I' is current and 'V' is voltage)...." This amendment is supported by the specification and consistent with the usage of I-V by those of ordinary skill in the art.

The Examiner objected to the inadvertent inclusion of "to" in line 1 of Claim 1 and to the absence of a comma in Claim 18. These errors have been corrected.

Claims 1, 4, 7, 8, 11, 14, and 17 stand rejected under 35 U.S.C. §102(b) as anticipated by Schetzina. Both of independent Claims 1 and 11, as amended, recite

> ...wherein at least one of the p and n contacts is a multi-layer contact external to the semiconductor heterostructure and including a metallic reflector layer and a continuous conductive layer that makes ohmic contact to the heterostructure.... (emphasis added)

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Applicants can find no teaching or suggestion in Schetzina of the recited multi-layer contact "external to the semiconductor heterostructure."

In paragraph 7 of the Office Action, the Examiner identifies in Schetzina's Figure 27 a multi-layer contact having an ohmic layer 19 and a reflector layer 13. Schetzina's layer 19 is part of an electrical heterostructure 12 that also includes a layer 18. Referring to Figure 1, Schetzina identifies electrical heterostructure 12 (and thus layers 18 and 19) as part of a larger heterostructure:

> [o]ptical emitter 10 is an integrated heterostructure including an optical heterostructure 11 and an electrical heterostructure 12. (column 9, lines 21-23)

Schetzina also states:

> [i]t will be understood by those having skill in the art that the integrated optical structure 11 and electrical structure 12 is epitaxially formed as a monolithic structure, with lattice match between adjacent layers so as to produce minimal dislocations at the junctions between the layers. (column 9, lines 47-53)

Hence, Schetzina's layers 18 and 19 are an integral part of a monolithic heterostructure. Consequently, the multi-layer contact identified by the Examiner is not "external to the semiconductor heterostructure" as recited in Claims 1 and 11, as amended.

For the above reasons, Claims 1 and 11, as amended, are patentable over Schetzina. Claims 4, 7, and 8 are patentable over Schetzina as a result of their dependence on Claim 1. Similarly, Claims 14 and 17 are patentable over Schetzina as a result of their dependence on Claim 11.

The Examiner made the following rejections under 35 U.S.C. §103(a): Claims 2 and 12 as unpatentable over Schetzina in view of Tischler, Claims 3 and 13 as unpatentable over Schetzina in view of Sugiura et al., Claims 5, 10, and 15 as unpatentable over Schetzina in view of Nakagawa et al., Claims 6 and 16 as unpatentable over Schetzina in view of Liu et al., Claim 9 as unpatentable over Schetzina in view of Yoshida et al., and Claim 18 as unpatentable over Schetzina in view of Okazaki.

None of Tischler, Sugiura et al., Nakagawa et al., Liu et al, Yoshida et al., or Okazaki remedy the defects of Schetzina with respect to the patentability of Claims 1 and 11, as amended. Consequently, Claims 1 and 11, as amended, are patentable over Schetzina in view of any of these references. Claims 2 and 12 have been canceled, rendering their rejections moot. Claims 3, 5, 6, 9, and 10 are patentable over the cited combinations of references as a

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result of their dependence on Claim 1. Claims 13, 15, 16, and 18 are patentable over the cited combinations of references as a result of their dependence on Claim 11.

For the above reasons, Applicants respectfully request reconsideration and allowance of Claims 1, 3-11, and 13-19. Should the Examiner have any questions concerning this response, the Examiner is invited to call the undersigned at (408) 453-9200.

I hereby certify that this correspondence is being deposited with the United States Postal Service as First Class Mail in an envelope addressed to: Commissioner for Patents, Washington, D.C. 20231, on November 20, 2001.

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20 Nov. 2001 — Date of Signature

Respectfully submitted,

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Appendix A

The paragraph beginning at page 6, line 1 is amended as follows.

The present invention is a multi-layer contact that consists of multiple material layers providing high reflectivity, low specific contact resistance, and high reliability. Figure 1 shows a cross-sectional embodiment of a semiconductor device 10 with a multi-layer contact 12. The multi-layer contact 12 includes an ohmic layer 12A and a reflective layer 12B. In combination, the ohmic and reflective layers 12A, 12B form a highly reflective ohmic electrical contact to semiconductor structure 11. Various optoelectronic semiconductor structures 11 can be used with the multi-layer reflective contact layers 12. Symbol hν in Figure 1 designates the path of a photon reflected by multi-layer contact 12.

The paragraph beginning at page 6, line 10 is amended as follows.

Ohmic layer 12A is at least one layer that provides a good ohmic contact to the semiconductor 11. A good ohmic contact has minimal voltage drop (linear I-V, where "I" is current and "V" is voltage) across the semiconductor/metal interface when current flows across it. A figure of merit for contacts is their specific contact resistance. The specific contact resistance varies greatly depending on the semiconductor and contact material, but a good ohmic contact should have a specific contact resistance of less than 10^{-2} Ω-cm^2. The ohmic layer 12A, which may be optionally alloyed to the semiconductor surface, is thin to minimize the absorption to less than 25% of the light generated in the semiconductor device 10 while being thick enough so that the specific contact resistance is less than 10^{-2} Ω-cm^2. The composition of the ohmic layer 12A depends on the material system used for the semiconductor structure 11. The thickness of the ohmic layer 12A depends upon on how the specific contact resistance increases as the layers are thinned.

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Appendix B

The following identifies the changes that the present submission makes to the claims in U.S. Patent Application Serial No. 09/469,652.

1. (Twice Amended) A light-emitting device comprising:

a semiconductor heterostructure [of semiconductor materials having to] including at least one p-type layer and one n-type layer; and

a p contact and an n contact, the p contact electrically connected to the p-type layer, the n contact electrically connected to the n-type layer, wherein at least one of the p and n contacts is a multi-layer contact [having at least one ohmic contact layer and one reflector layer] external to the semiconductor heterostructure and including a metallic reflector layer and a continuous conductive layer that makes ohmic contact to the heterostructure;

wherein the multi-layer contact has a reflectivity greater than 75% for light at an operating wavelength of the light-emitting device.

2. (Canceled)

4. (Amended) A device, as defined in claim 1, the multi-layer contact further comprising a barrier layer interposing [the ohmic contact layer and] the reflector layer and the conductive layer.

6. (Amended) A device, as defined in claim 1, wherein the conductive layer that makes ohmic contact to the heterostructure [ohmic contact layer] has a thickness less than 200 Å.

7. (Amended) A device, as defined in claim 1, wherein the reflector layer is selected from [a] the group [that includes] consisting of Al, Cu, Rh, Pd, and Au.

9. (Amended) A device, as defined in claim 8, wherein the conductive layer that makes ohmic contact to the heterostructure [ohmic contact layer] includes Ni and Ag.

11. (Twice Amended) A light-emitting semiconductor device comprising:

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a GaN-based semiconductor heterostructure having at least one p-type and one n-type layer; and

a p contact and an n contact, the p contact electrically connected to the p-type layer, the n contact electrically connected to the n-type layer, wherein at least one of the p and n contacts is a multi-layer contact [having at least one ohmic contact layer and one reflector layer] external to the semiconductor heterostructure and including a metallic reflector layer and a continuous conductive layer that makes ohmic contact to the heterostructure;

wherein the multi-layer contact has a reflectivity greater than 75% for light at an operating wavelength of the light-emitting device.

12. (Canceled)

14. (Amended) A device, as defined in claim 11, the multi-layer contact further comprising a barrier layer interposing [the ohmic contact layer and] the reflector layer and the conductive layer.

15. (Amended) A device, as defined in claim 11, [wherein] the reflector layer having a thickness greater than 500Å.

16. (Amended) A device, as defined in claim 11, [wherein] the conductive layer that makes ohmic contact to the heterostructure [ohmic contact layer] having a thickness less than 200 Å.

17. (Amended) A device, as defined in claim 11, the reflector layer being selected from [a] the group [that includes] consisting of Al, Cu, Rh, Pd, and Au.

18. (Amended) A device, as defined in claim 11, wherein the conductive layer that makes ohmic contact to the heterostructure [ohmic contact layer] is selected from [a] the group that consists of Ti, Au/NiO, and Ni/Au.

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